

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re application of: **SYSTEM AND METHOD TO MINIMIZE THE AMOUNT OF NOX EMISSIONS BY OPTIMIZING THE AMOUNT OF SUPPLIED REDUCTANT**

April 30, 2007

Serial No.: 10/756,876

Group Art Unit: 3748

Filed: January 13, 2004

Examiner: Tu Minh Nguyen

For:

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Sir:

We declare as follows:

1. We are the named inventors of U.S. Patent Application Serial No. 10/756,876, filed January 13, 2004, and entitled **SYSTEM AND METHOD TO MINIMIZE THE AMOUNT OF NOX EMISSIONS BY OPTIMIZING THE AMOUNT OF SUPPLIED REDUCTANT**.

2. We conceived of our invention in this country before September 17, 2003, the filing date of the application resulting in United States Patent Application No. US 6,834,497 as demonstrated by Exhibit A titled "Invention Disclosure - Questionnaire Template" and Exhibit B titled "Minimization of the Purge NOx Release from a Lean NOx Trap by Optimizing the Amount of Reductant during the Purges", which are attached to this declaration.

3. Exhibits A and B were submitted by the inventors to an electronic disclosure system of the assignee of U.S. Patent Application Serial No. 10/756,876

before September 17, 2003, were they were electronically time stamped, thereby demonstrating that we conceived of the subject matter of claims 1 - 15 of U.S. Patent Application Serial No. 10/756,876 as originally filed before September 17, 2003.

4. Specifically, Exhibits A and B demonstrate that before September 17, 2003, we conceived of a method for controlling an engine having an exhaust with an emission control device capable of storing NOx during lean operating conditions, and converting at least a portion of said NOx during stoichiometric or rich operating conditions, the method comprising: 1) operating the engine to produce a lean exhaust gas mixture fed to the emission control device; 2) after said lean operation, operating the engine to produce a rich exhaust gas mixture fed to the emission control device, said rich air-fuel ratio determined as a function of at least the oxygen storage capacity of the device.


5. Specifically, Exhibits A and B demonstrate that before September 17, 2003, we conceived of a method for controlling an engine having an exhaust with an emission control device capable of storing NOx during lean operating conditions, and converting at least a portion said NOx during stoichiometric or rich operating conditions, the method comprising: 1) operating the engine to produce a lean exhaust gas mixture fed to the emission control device; 2) estimating the amount of NOx release based on the oxygen storage capacity of the device; 3) after said lean operation, operating the engine to produce a rich exhaust gas mixture fed to the emission control device, said rich air-fuel ratio is determined based at least on the amount of NOx released.

6. From before September 17, 2003 until January 13, 2004, the filing date of U.S. Patent Application Serial No. 10/756,876, we diligently worked toward perfecting the filing of the application.

7. All acts set forth herein and/or relied upon for the purpose of establishing invention prior to September 17, 2003 were carried out in the United States.

8. We declare that all statements made herein of our knowledge are true and all statements made on information and belief are believed to be true. These statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under § 1001 of Title 18 of the United States Code. We understand that such willful false statements may jeopardize the validity of the application or any patent issuing therefrom.

Date: 4/30/2007


Christian Goralski Jr.

Date: _____

Gopichandra Surnilla

Date: _____

Joseph Theis

Date: _____

Hungwen Jen

Date: _____

Justin Ura

EXHIBIT A**OLID INVENTION DISCLOSURE**

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 back

Survey Id: 8449

Mapped Record Id: 81039181

(* indicates mandatory fields)

INVENTION DESCRIPTION**FILLING IN THE FORM**

There are seven sections on this page and listed in the menu on the left side of the screen you will find the screens for entering Inventors, Related Art and documents. You can click on the link to go to that section

SAVING YOUR INFORMATION

You can fill the sections in any order. After completing each section, click on the Save button. You must save before leaving a section.

EDITING YOUR DRAFT

If you decide not to complete all sections in a single session, you can simply leave the site or close the browser. You can subsequently login again and continue from where you left off.

SUBMITTING YOUR COMPLETED DRAFT

After you fill in and review all the sections, then click on 'Inventors' on the left and then press the 'Ready for Approval' button. All Inventors must view the draft and approve it for submission. Your invention disclosure will be submitted to Ford's Global Technologies office automatically after all inventors approve.

**1. Invention Title (Required)**

Provide a fully-descriptive Title for your Invention, up to 2 lines in length.

THE PURGE NOX RELEASE FROM A LEAN NOX TRAP IS MINIMIZED BY PROVIDING A LEVEL OF REDUCTANT (CO/H₂) THAT IS A FUNCTION OF THE TEMPERATURE AND OSC OF THE TRAP.

2. Short Title (Required)

Provide Short Title for your Invention, up to 40 characters in length.

3. Originating Company (Required)**4. Originating Country (Required)**

United States of America 64000134

PROBLEM AND SOLUTION**5. Problem (Required)**

Describe the problem you were trying to solve that lead to your development.


The purge NOx release from a lean NOx trap depends on the temperature, the OSC of the trap, the amount of NOx stored, and the amount of reductant supplied (i.e., CO/H₂). It is proposed that the NOx release can be controlled by supplying a level of reductant during the purge that depends on the temperature and measured OSC of the trap. As the OSC of the trap decreases during aging, the level of reductant can be reduced while still limiting the purge NOx release.

Diagrams

Create appropriate diagrams (schematics, drawings, sketches, flowcharts, etc.) to illustrate your proposed solution. Attach these using the "Documents" menu option on the top left hand side of the screen.

6. Your Solution (Required)


EXHIBIT A

-  Referring to the diagrams attached in Question 2, describe the solution you propose in broad, conceptual terms. (Additional detail may be given in the Part F, Detailed Description, below.)

7. Results of Solution (Required)


Describe each of the results achieved by your solution.

INVENTORS


-  **Inventors and Other Contacts**
Using the button on the left, add all Inventors and other persons who should have access to this Invention Disclosure. The creator must add all other Inventors and Non-Inventors to allow them access.

PREVIOUS SOLUTIONS**8. Differences/Advantages of Your Solution (Required)**

Describe the structural and/or functional differences between your solution and previous solutions, and the advantages of your solution over the previous solutions.

-  **9. Related Art**
Identify the closest technology of which you are aware. Attach any patents or other publications using the button at the left of this page, Related Art. If necessary, enter a brief description of any attached documents. Failure to identify the most relevant related art of which you are aware may result in a patent resulting from this disclosure being invalid and unenforceable.

DATES

-  **10. First Record of Invention (Required)**
Describe the first record of this invention, including where you wrote/recorded it, and whether anyone else was present as a witness. (If this is the first record, please indicate.)

This is the first record of invention. It was recorded on Date has been redacted

11. Date of First Record (Required)

Provide the date on which you made the record of the invention

/ /

12. Date of Working Model

If applicable, provide the anticipated or completed date of the first working model, prototype, or demonstrated result of this invention.

Date has been redacted

-  **13. Date of First Planned Usage**
Provide the anticipated or planned date of the first production usage of this invention. (Do not enter a date based upon wishful thinking.)

/ /

-  **14. Planned Usage**

Date has been redacted

15. Use Duration

How long do you expect your Invention to be used? (for example: 2 years)

EXHIBIT A**16. External Disclosure**

If this invention has been discussed with or otherwise disclosed to non-company personnel, provide their name(s) and contact details (telephone number, address, e-mail, etc.) AND If you have worked with someone at FGTI, please identify him or her here.

DETAILED DESCRIPTION**17. Detailed Description (Required)**

If appropriate, provide a description of the invention in greater detail than given above in Part C Problem and Solution. Include alternative ways to build/design/perform the invention. (The more detail you provide, the greater the chance that FGTI will be able to identify a patentable invention.)

Details are provided in the attached file. The amount of purge NOx release is minimized by supplying an amount of reductant (CO and H2) during the purge that is a function of the measured OSC of the trap and the trap temperature (measured or modeled). As the OSC of the trap decreases during aging, the amount of reductant (i.e., the magnitude of the rich A/F ratio) can be decreased while still limiting the purge NOx release.

**18. Related Invention Disclosure(s)**

Provide the Invention Number of any related invention disclosures

EXHAUST SYSTEM

ADDITIONAL INFORMATION

19. If disclosed to non-Company personnel, identify recipient and date OR If you have worked with someone in FGTI, please identify that person.

none

20. Approval to submit was given by:

Date has been redacted

21. New Technology Description:

**22. Replacement Part**

Does this invention relate to a replacement part?

No

**23. CPSC Code (Required)**

Please make sure CPSC is selected from the classification drop down.



Non-related information has been redacted

25. Innovation Acceleration Center, Dearborn MI

Is this invention potentially related to any session at the Innovation Acceleration Center in Dearborn, MI?

26. Innovation Acceleration Center Contact

If your invention is related to any session at the Innovation Acceleration Center in Dearborn, MI, please select your FGTI contact.

**27. Government Contract (Required)**

Was this invention developed under a government contract?

EXHIBIT A

No

**28. Government Contract Number**

If you answered Yes to question 28, provide the government contract number.

29. Involved Organizations

If any other company, consortium, partnership, or government agreement was involved with the conception, development, or first building of this invention, provide their name(s) and contact details (telephone number, address, e-mail, etc.).

none

**30. Potential Licensing Opportunities**

Identify any potential licensing opportunities within and, if appropriate, outside the auto industry.

31. Potential Licensing Contacts

If you identified any potential licensing opportunities in question 31, provide company name(s), contact name(s), and contact details (telephone number, address, e-mail, etc.) of potentially interested parties.

**32. Patent Committee (Required)**

Please select the Patent Committee for internal review.

33. Project Number

Please provide any Project Number to which this disclosure is related.

34. Work Task Number

Please provide any Work Task Number to which this disclosure is related.

SUPPLEMENTARY QUESTIONS

35. How does the composition differ from prior art compositions (either describe a different element or different proportions and how these differences provide improved properties)?

36. Does it replace an existing material?

37. How is it used?

38. What can you do with this composition?

39. Provide any measurements made on the composition (melting point, IR spectrum, transmission wavelength, hardness, etc.)

40. Provide yield information.

41. Described any intermediate products necessary to understand the composition.

EXHIBIT A

42. Provide starting materials and briefly describe how the composition was made.

43. Provide a description of the elements of the composition including the proportions of each. If the composition is an organic compound, please provide the chemical structure and proposed chemical name

44. Does the invention relate to a new composition or a method of preparing a composition or both (select Composition, Method or Both)?

INVENTORS

Name	Email	Phone	Approved	Signature
Christian Goralski Jr.				
Gopichandra Surnilla				
Joseph Theis	Personal contact information has been redacted			
Hungwen Jen				
Justin Ura				

RELATED ART

Type / Number / Description / Owner

: , Search Results Date has been redacted

[View Related Art](#)

TERMS AND CONDITIONS

Version Number / Text

DOCUMENTS

Document/Title

Your original attachment file : NOx_release_Vary_CO_level.doc was renamed.

Date

Document Type

Date has been redacted

EXHIBIT B

Minimization of the Purge NO_x Release from a Lean NO_x Trap by Optimizing the Amount of Reductant during the Purges

Abstract

Lean NO_x Traps can be used to treat the NO_x emissions from lean-burn engines by storing the NO_x under lean conditions and reducing the stored NO_x during periodic rich purges. NO_x traps are most effective at storing NO_x during lean operation in the temperature range of 250°C to 500°C. It has been observed that, during the purges, some NO_x traps can release some of the stored NO_x without reducing it to N₂. This purge NO_x release is particularly evident above 350°C and increases with increasing temperature, the amount of NO_x stored, the amount of oxygen storage capacity (OSC) in the trap, and the amount of reductant (CO and H₂) provided during the purge. It is proposed that the amount of purge NO_x release can be controlled by providing a concentration of reductant that is a function of the measured temperature and OSC of the trap. Higher levels of reductant are needed at higher temperatures. Also, high concentrations of reductant are needed when the OSC of the trap is high. As the OSC of the trap decreases during aging, the concentration of reductant can be reduced while still limiting the amount of purge NO_x release.

Background

Three-Way Catalysts

Current three-way catalysts are effective for converting the HC, CO, and NO_x in the exhaust into CO₂, H₂O, and N₂ when the A/F ratio is controlled about the stoichiometric mixture of 14.6 to 1. With the closed-loop control systems used in modern vehicles, the A/F ratio actually alternates between a slightly lean condition and a slightly rich condition with a frequency of 1-2 Hz and at an amplitude of approximately 0.3 to 0.5 A/F ratio units. To provide high three-way conversion in this oscillatory environment, three-way catalysts usually contain oxides of cerium or mixed oxides of cerium and zirconium. For the short periods of slightly lean exhaust, the cerium is able to adsorb the excess oxygen, allowing the NO_x reduction to continue. The cerium also releases oxygen during the short periods of slightly rich exhaust, providing oxidants for converting the HC and CO. This combination of tight A/F ratio control and the modern three-way catalyst provide very high conversion efficiencies of the HC, CO, and NO_x and allow automakers to satisfy stringent emission legislation in markets around the world.

Lean-burn Engines

It is desirable to operate the engine lean in order to improve the fuel economy. By opening up the air throttle plate and operating the engine with excess air, the pumping losses across the throttle plate are reduced and the thermodynamic efficiency of the engine is improved, resulting in decreased fuel consumption. However, the exhaust from such an engine contains large amounts of excess oxygen for extended periods of time (e.g., 30 to 60 seconds), and current three-way catalysts are unable to provide the NO_x control necessary to satisfy stringent emission legislation in this environment.

NO_x Traps

One potential solution to this emission and fuel economy dilemma is to use a lean NO_x trap. Lean NO_x traps are three-way catalysts and, like all such catalysts, can store NO_x under lean conditions. The NO_x traps contain alkali-earth or alkali metals to enhance their NO_x storage capabilities under lean conditions. Such catalysts can store NO_x with high efficiency for a period of time on the order of 60 seconds. Periodically, as the NO_x capacity of the NO_x trap is approached, the A/F ratio must be driven to a rich condition for a few seconds in order to purge and reduce the stored NO_x and regenerate the NO_x storage capacity of the trap.

One of the characteristic features of lean NO_x traps is that they are most effective at storing NO_x in a temperature window that can vary somewhat with the formulation but is typically around 250°C to 500°C. Figure 1 shows the NO_x storage efficiency averaged over 1, 2, 3, 4, and 5 minutes of lean operation for a thermally aged lean NO_x trap when evaluated on a five minute lean/3 minute rich test cycle. The peak NO_x storage performance occurred around 400°C to 450°C and dropped off at lower and higher temperatures. As a

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result of this temperature sensitivity, the NO_x traps are typically placed in the underfloor location in the exhaust. Small lightoff catalysts can be placed close to the exhaust manifold to provide fast lightoff during a cold-start test. These lightoff catalysts can be formulated with little or no oxygen storage capacity (OSC) in order to minimize the fuel required to purge and regenerate the lean NO_x trap.

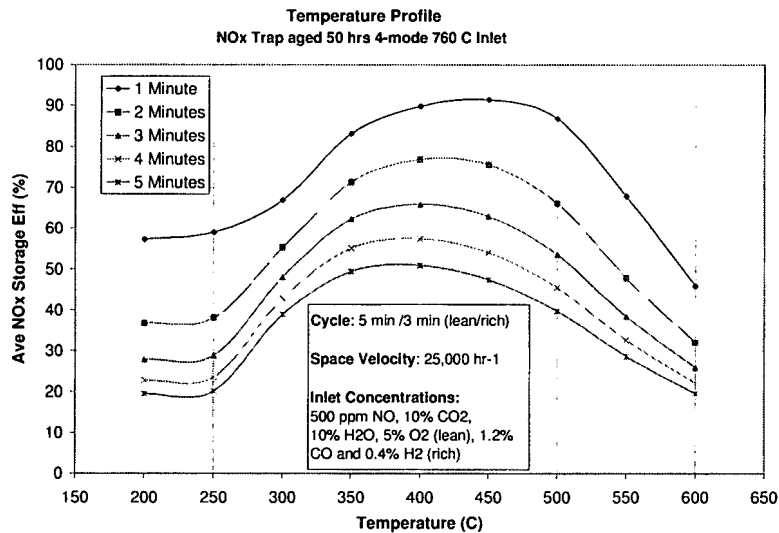


Figure 1. NO_x storage efficiency of a thermally aged NO_x trap for various times at different temperatures.

Lean NO_x traps can provide very high conversions of NO_x during lean/rich cycling. However, the catalyst system is also expected to provide high 3-way conversion when the A/F ratio is controlled at stoichiometry, for example during high load operation. If the close-coupled catalysts contain low amounts of OSC, this limits the ability of these catalysts to convert CO and NO_x under the oscillatory A/F conditions characteristic of closed-loop control systems. Therefore, unless there is a cerium-containing three-way catalyst downstream of the NO_x trap, the NO_x trap itself must contain some OSC in order to provide high CO and NO_x conversion under these conditions. Figure 2 shows that a NO_x trap containing cerium had much better NO_x

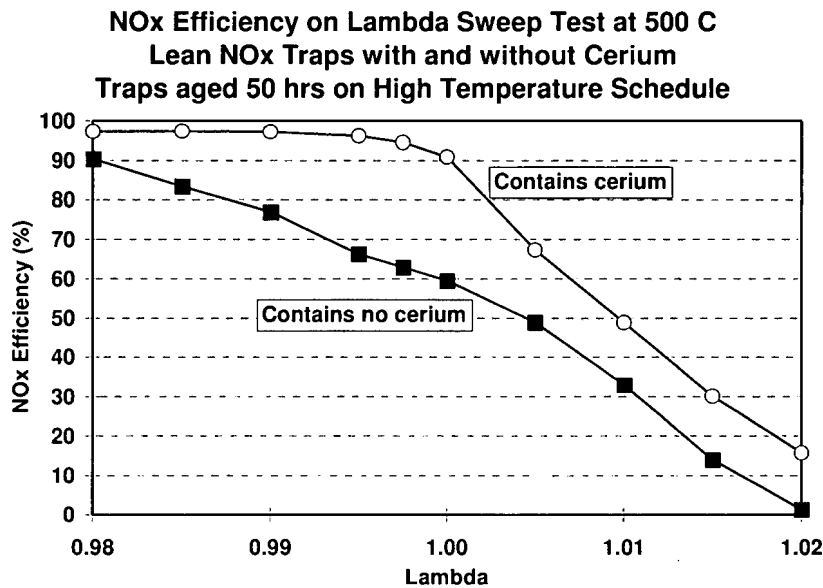


Figure 2. NO_x Efficiency versus lambda value at 500°C for NO_x traps with and without cerium after high temperature aging.

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conversion at stoichiometry ($\lambda = 1.0$) than a trap without cerium after the traps were aged on a high temperature schedule with maximum temperatures near 1000°C .

The presence of cerium in the NO_x trap has been observed to provide other benefits besides improving the stoichiometric performance of the trap. The cerium can improve the sulfur tolerance of the trap by adsorbing some of the sulfur and preventing that portion of the sulfur from poisoning the NO_x storage sites. Figure 3 shows the sulfur poisoning results for NO_x traps containing various amounts of a cerium-containing mixed oxide. Prior to the poisoning runs, the traps were exposed to 2 hours of high temperature aging in order to stabilize their performance. The poisoning test consisted of a one minute lean/one minute rich cycle, and the NO_x storage efficiencies were averaged over the one minute of lean operation. The figure shows the drop in average NO_x storage efficiency between 0 hours and 9 hours for traps that were poisoned five times each at 400°C with 9 ppm SO_2 . After each poisoning run, the traps were desulfated at high temperatures to remove the sulfur and regenerate the trap. Figure 3 shows that the drop in storage efficiency over the 9 hours of poisoning decreased as the content of mixed oxide was increased from 0 % to 37 %; no further improvement was observed with higher contents of mixed oxide. The trap with no mixed oxide had an average drop in NO_x storage efficiency of about 40 %, while the trap with 37 % mixed oxide had an average drop in NO_x storage efficiency of about 16 %. These results indicate that the presence of cerium in the NO_x trap improves the sulfur tolerance of the trap.

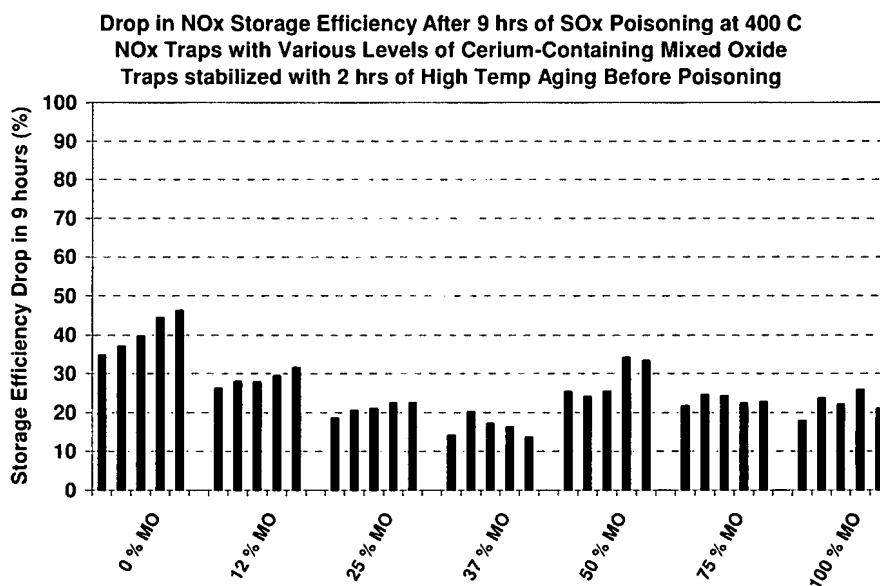


Figure 3. Drop in NO_x storage efficiency after 9 hours with 9 ppm SO_2 at 400°C for NO_x traps with different levels of a cerium-containing mixed oxide. Storage efficiency averaged over 1 minute of lean operation. Each sample was poisoned and desulfated five times.

The cerium also improves the desulfation characteristics of the trap by promoting the water-gas-shift (WGS) reaction. The WGS reaction produces additional hydrogen, which has been shown to be the best agent for desulfating the poisoned trap. The presence of cerium can also improve the NO_x storage capability at low temperatures, as cerium is able to provide some NO_x storage capacity at low temperatures (e.g., 300°C). Finally, the cerium can be beneficial for the thermal durability of the trap, as ceria is known to stabilize the dispersion of the precious metals.

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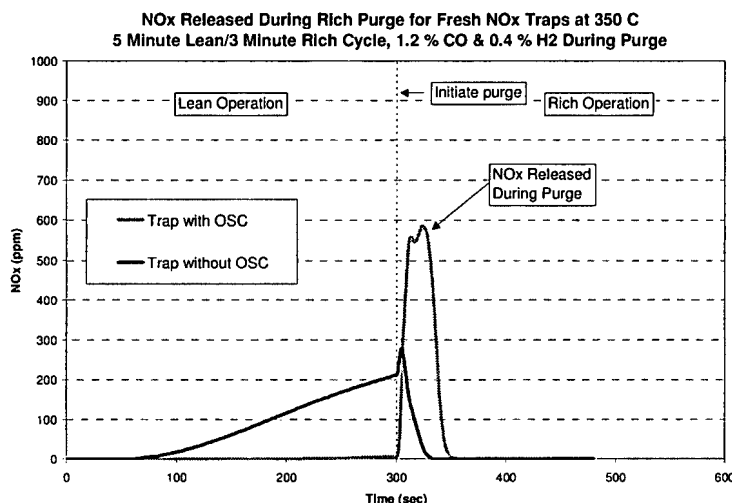


Figure 4. NO_x storage and release performance at 350°C for stabilized traps with and without cerium.

NO_x Release Characteristics of NO_x Traps

However, the presence of cerium in the trap can also be responsible for some undesirable effects. As with the lightoff catalysts, cerium in the trap requires additional reductants (i.e., HC, CO, H₂) during the purges, increasing the fuel penalty associated with the purges. A second undesirable effect, which is the subject of this disclosure, is that the oxygen storage capacity provided by the cerium can cause some of the stored NO_x to be released from the trap during the purges without being reduced to N₂. This purge NO_x release is particularly evident at temperatures of 350°C and above. Figure 4 demonstrates this NO_x release for a stabilized trap with no oxygen storage capacity and a stabilized trap containing oxygen storage capacity. These traps were evaluated at 350°C using a 5 minute lean/3 minute rich cycle. While the trap without OSC was less effective at storing NO_x during the 5 minute lean period, it exhibited much less NO_x release during the purge than the trap containing OSC.

The amount of NO_x stored during the lean period and the amount of NO_x released during the rich period were calculated, and the amount of NO_x release was then determined as a percentage of the amount of NO_x stored. Figure 5 shows this percent NO_x release at different temperatures for the NO_x traps with and without OSC. For both NO_x traps, the percent NO_x release generally increased as the temperature increased beyond 350°C. The trap with OSC had a significantly higher percentage of NO_x release than the trap without OSC at these higher temperatures.

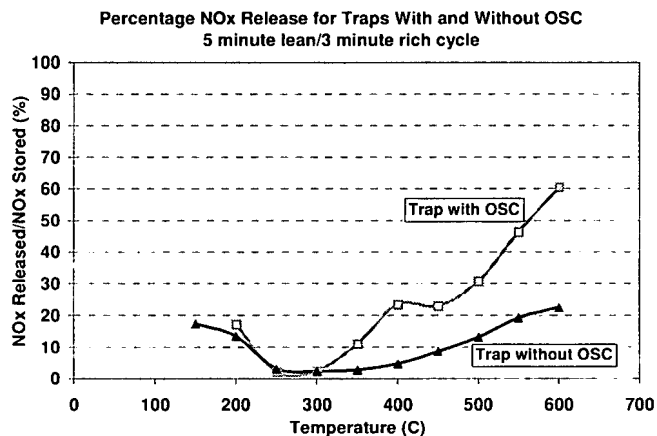


Figure 5. Percent NO_x release at different temperatures for stabilized NO_x traps with and without OSC.

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A major source of this purge NO_x release is attributed to the exotherm that results from the reaction between the reductants in the exhaust and oxygen from the cerium. This exotherm heats up the local area of the washcoat around the cerium site, including any NO_x storage sites nearby. Referring to Figure 6, if the temperature before the purge is near or above the temperature for maximum NO_x storage capacity (i.e., in the range of decreasing NO_x capacity) and the amount of NO_x stored is near the capacity of the trap at that temperature, then the exotherm between the reductants and oxygen from the cerium causes some of the NO_x to be released from the nearby NO_x storage sites in order to bring the amount of NO_x stored back to the maximum amount that can be stored at the higher surface temperature. Since the reductants have been converted by the oxygen from the cerium, the released NO_x is not reduced but is emitted from the trap into the exhaust and out the tailpipe. Another possibility is that the oxygen released from the ceria competes with the released NO_x for the reductants. As a result of this competition, some of the NO_x is not reduced but is emitted from the tailpipe.

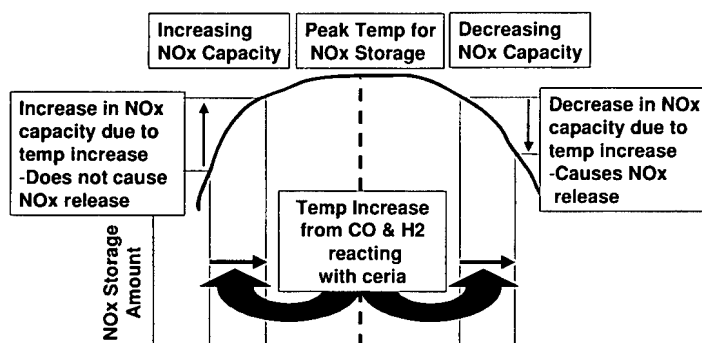


Figure 6. Pictorial showing how exotherm produced by the reaction of the reductants with oxidized ceria can cause the release of NO_x from the trap at high temperatures.

Current Disclosure

Figure 5 indicated that the percentage of NO_x release depends on the temperature and the oxygen storage capacity of the trap. The amount of NO_x release is also a strong function of the amount of reductant (i.e., CO, H₂, HC) supplied to the trap during the purge. A NO_x trap pre-conditioned at 600°C was evaluated for NO_x storage and NO_x release at 500°C using a test cycle with a lean period of two minutes and a rich period of one minute. The CO level during the rich purges was varied from 0.5 % to 13 %. Figure 7 shows the tailpipe NO_x for these tests with the different purge CO levels. The amount of NO_x release decreased significantly as the purge CO level increased. This shows that the amount of NO_x release can be decreased by providing higher concentrations of reductant during the purges (i.e., by using richer A/F ratios during the purges). As suggested by Figure 5, the amount of reductant needed to minimize the NO_x release will depend on the temperature and the level of OSC in the trap.

To quantify the amount of reductant required to minimize the purge NO_x release, studies were performed on NO_x traps that contained different amounts of a ceria-containing mixed oxide. After stabilization at 600°C, samples of these traps were evaluated for oxygen storage capacity at different temperatures. Here the sample was reduced for 30 seconds in 1 % CO and then oxidized for 30 seconds in 0.5 % O₂. The total OSC was determined from the amount of oxygen taken up during the 30 second lean period and normalized by the weight of the sample. The "fast" OSC was defined as the amount of oxygen taken up by the trap before any breakthrough of oxygen occurred. Oxygen storage tests were also performed on samples of these traps that had been aged for 50 hours on a high temperature aging cycle with maximum temperatures of 1000°C. Figure 8 shows the fast OSC results for the fresh and aged samples at 425°C.

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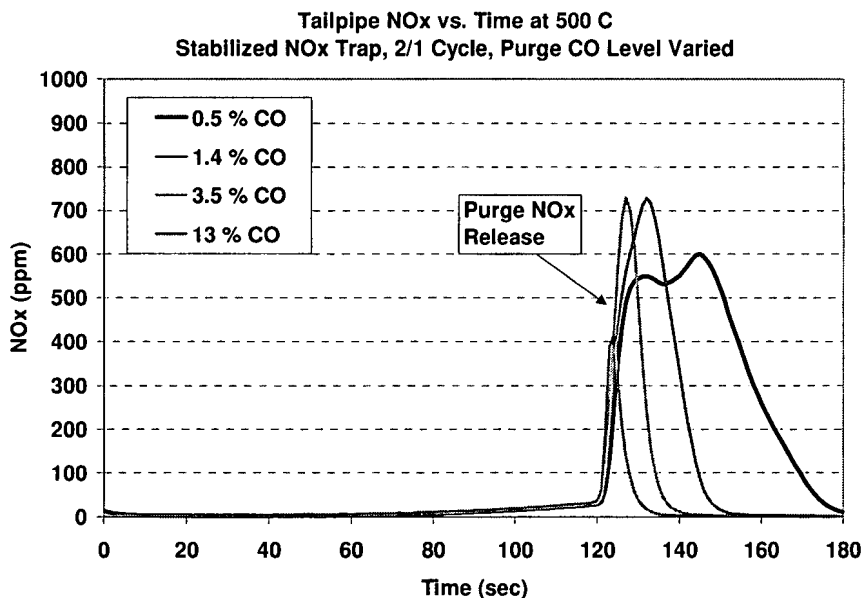


Figure 7. Tailpipe NO_x at 500°C for 2/1 test cycle with various CO levels during the rich purges.

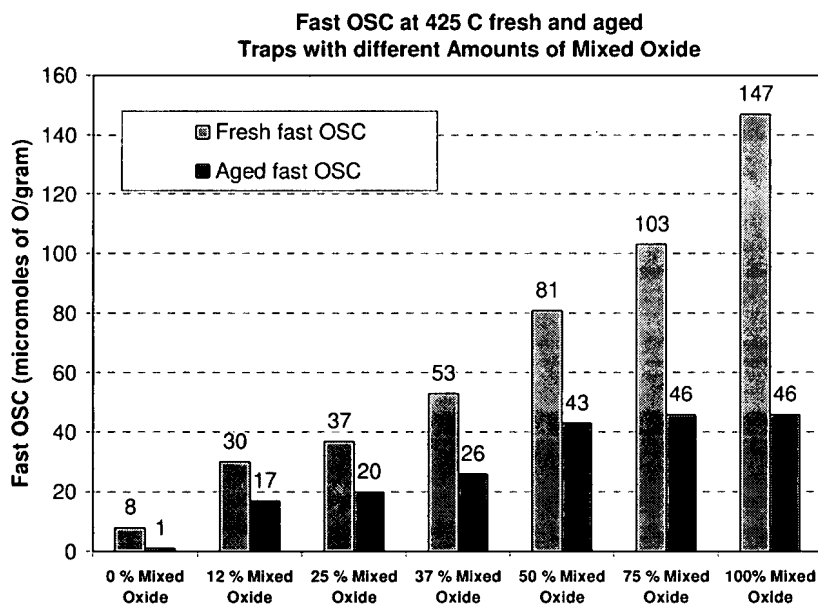


Figure 8. Fast OSC results at 425°C for stabilized and thermally aged NO_x traps with different amounts of a cerium-containing mixed oxide.

Samples of the traps stabilized at 600°C were evaluated for NO_x storage and NO_x release at 425°C by utilizing the 2/1 cycle. The CO level during the rich purges was varied from as low as 0.5 % to as high as 16 %. During the purges, the feedgas also contained H₂ at 1/3 of the CO level to reflect the approximate ratio of these species in actual engine exhaust. The amount of NO_x storage was relatively constant at around 12-13 mg/in³ for these tests. The amount of NO_x release was calculated for the different levels of CO and normalized by the volume of the sample. Figure 9 shows the amount of NO_x release as a function of the purge CO level for samples with 0 % and 75 % mixed oxide, which had oxygen storage levels of 8 and 103

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micromoles O/gram of trap. For a given level of CO, the sample with 0 % MO had much lower NO_x release than the sample with 75 % MO. In other words, a much higher level of CO was required for the high OSC trap to achieve the same NO_x release as the low OSC trap.

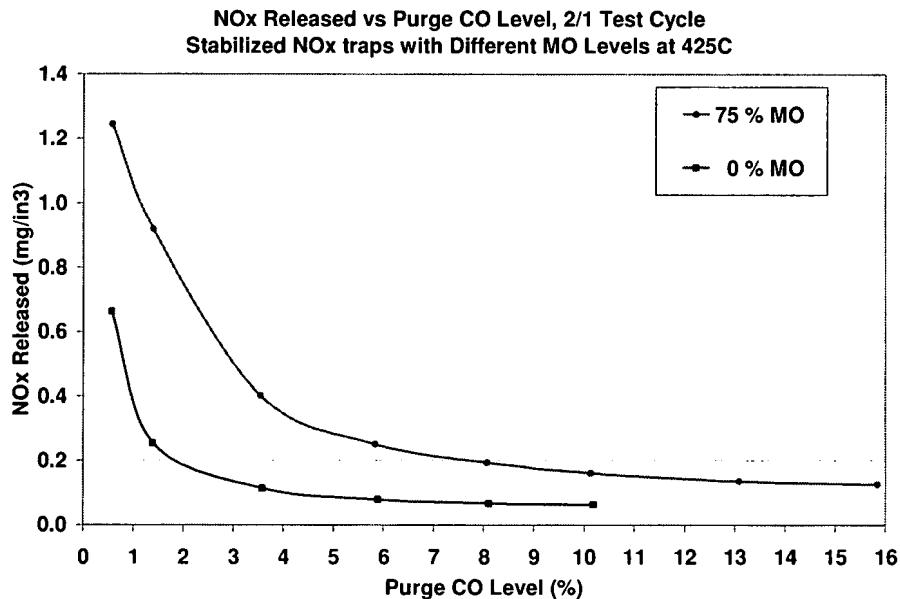


Figure 9. NO_x Release versus purge CO level on 2/1 cycle at 425°C for stabilized NO_x traps with different levels of mixed oxide.

Similar data was collected for samples with 12 % and 37 % mixed oxide. The data for these four traps were analyzed to determine the amount of CO required to achieve specified levels of NO_x release. Figure 10 shows the CO required to achieve NO_x release levels of 0.2, 0.4, 0.6, 0.8, and 1.0 mg/in³ as a function of the measured OSC of the sample. To achieve a constant level of purge NO_x release, less reductant is required as the OSC of the trap decreases.

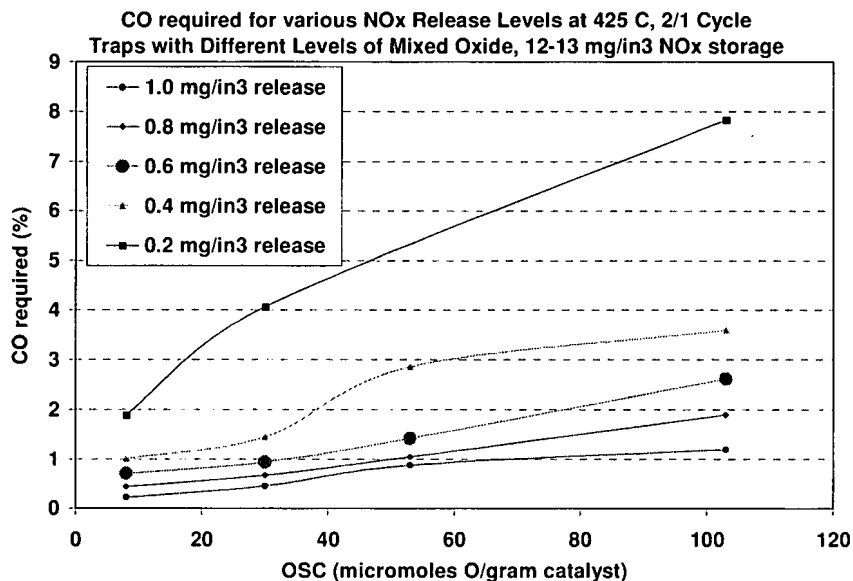


Figure 10. CO required to achieve various levels of NO_x release on 2/1 cycle at 425°C for stabilized NO_x traps with different levels of mixed oxide.

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Similar OSC and NO_x release results were obtained at 500°C. A permissible level of NO_x release needs to be specified so that the required level of CO can be determined for the different levels of OSC. As an example, a level of 0.6 mg/in₃ was specified. Figure 11 shows the CO required to achieve a NO_x release of 0.6 mg/in₃ at both 425°C and 500°C. For a given level of OSC, much more CO is required at 500°C than at 425°C to achieve the 0.6 mg/in₃ of NO_x release.

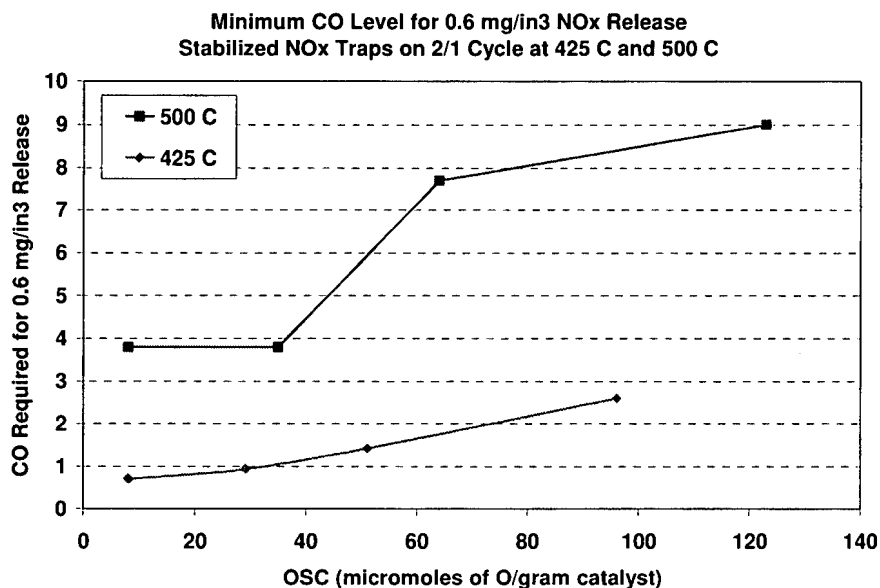


Figure 11. CO required to achieve 0.6 mg/in³ NO_x release on 2/1 cycle at 425°C and 500°C for stabilized NO_x traps with different amounts of mixed oxide.

Control Strategy

The amount of OSC in the trap can be estimated from the difference in switch times during the rich-to-lean transition. The bed temperature of the LNT can be measured using a thermocouple or estimated from a temperature model. The bed temperature and the measured amount of OSC can be used with Figure 11 to determine the amount of CO necessary to limit the NO_x release to the specified level, which is 0.6 mg/in³ in this example. For fresh or stabilized traps that have high levels of OSC, very rich purges will be necessary to limit the purge NO_x release to the desired level. However, as the trap ages and the OSC decreases, the magnitude of the purge can be decreased while still limiting the purge NO_x release.

Joseph Theis
Chistian T. Goralski
Gopichandra Surnilla
Justin Ura
Hungwen Jen

Date has been redacted